

ECE 198

Project Proposal

Adon Ojha and Rashad Jayshanth-Nizar
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Customer Problem

The target customer for this project is individuals aged 65 and above who are suffering from Alzheimer's, along with their families and caregivers. This group of individuals, along with their support network, will be the primary users and beneficiaries of the engineered medication dispenser. Alzheimer's is a type of dementia, a neurocognitive disorder that has severe effects on an individual's memory and thinking skills, worsening with time to eventually struggling to carry out simple tasks [1].

The problem that this project aims to address is the significant challenge of medication management faced by elderly individuals with Alzheimer's. The nonprofit organization MemoryLane Care Services offers care and support for people living with Alzheimer's and related disorders, and their article on medication management [2] ignited our drive to make a project in this domain. Research and information from various sources indicate that these individuals often struggle to adhere to their prescribed medication regimens due to memory issues, cognitive impairment, and the complexity of medication schedules [2]. This non-adherence can lead to severe health consequences through not meeting the required dosage and/or overdosage, increased healthcare costs, and a reduced quality of life for the elderly individuals and added stress for their families and caregivers.

While the problem has been well-documented, this project will specifically focus on designing a medication dispenser to alleviate these challenges and improve medication management for this target group. The dispenser will aim to ensure the correct medications are dispensed at the right time, provide reminders, and offer ease of use for both the elderly individuals and their caregiver.

Stakeholders:

1) Graduate TA (Shadi Vandvajdi)

The graduate TA assigned to our group will evaluate all of the work put towards this project and contribute to the overall project success.

2) Elderly Alzheimer's Patients

Needs:

- Simplified medication management to reduce confusion
- Accurate dosage reminders
- Increased independence and quality of life

Concerns:

- Ease of use, accessibility of dispenser

3) Families and caregivers of an Alzheimer's patient

Needs:

- Assurance that their loved one is taking medications correctly
- Reduced stress and relieved burden of care taking

Concerns:

- Accuracy and reliability of device
- Affordability

4) Healthcare Professionals (Doctors, Nurses, Pharmacists)

Needs:

- Simplified medication management for Alzheimer's patients

Concerns:

- Integration/compliance with existing healthcare system

Initial Requirements

Functional requirements

- Speaker will notify customer when it's time to have medication through a voice prompt
 - Voice prompt will be played at 55 dB, a loud but safe noise level for elderly to ensure they hear the prompt [3]
- LCD screen will be at a safe and practical brightness level of 200-400 nits. This will be sufficient since the device will be kept indoors at all times, and the screen will not need to be any larger than 400 nits [4].
- Can hold up to 7 medication containers at once. Users caregiver will insert medication capsules in the correct order which will be released into the capsule holder

Technical requirements

- LCD screen has a refresh rate of 60Hz
- LCD screen and inner mechanics are able to refresh according to current function:
 - When user is setting up time intervals, they input through buttons and with the help of the LCD screen:
 - # of containers needed per day
 - Time of first dosage (in 12h format)
 - Time interval for subsequent dosage(s) (in hours)
 - When medication time is equal to current time:
 - LCD screen will display a reminder message
 - Release arm will release current dosage into capsule holder

Safety requirements

- The dispenser should not contain more than 500mJ of energy at any point in time
- The maximum amount of power that can be used at once is 30W, to prevent overheating and harm to the customer
- All wires will be concisely organized and hidden
- Device will be grounded to prevent static electricity buildup

Principles

1. Newton's Second Law of motion: Newton's second law of motion describes an object's behavior where all forces are unbalanced. It explains the fact that an object's acceleration relies on the mass as well as the net force acting on the object. As the mass of an object as well as the force acting upon it increases, the acceleration decreases [5]. The equation for Newton's second law of motion is $F=ma$ which means the force acting on an object is equal to the mass multiplied by the acceleration of the object. This principle can be directly applied to our medication dispenser since the force of gravity will be used in order to dispense the medication. When one container of medication is pushed out of the machine, the next container will fall into position due to gravity ($F_g = mg$), and will thus be ready to be pushed out at the next consumption time.
2. Ohm's Law: Ohm's Law describes the relationship between voltage, current, and resistance in an electrical circuit. The formula for Ohm's Law is $V=IR$ which means the voltage is equal to the current multiplied by the resistance in an electrical circuit [6]. This principle will be applied to the electronic part of our project. It will ensure a safe and reliable operation of our device, as well as proper voltage, current, and resistance levels. It will be very relevant as our inner electrical circuits and components will exploit this principle
3. Interval Calculation: Time interval calculation describes the concept of dividing a large number into shorter periods of time within the same length [7]. The formula for the intervals in our project will be $T(\text{time}) = \text{Total time}(24 \text{ hours}) / \text{Amount of daily doses}$. This principle will be applied to the timer aspect of our project, and help us determine the amount of doses we need to dispense per day.

References

- [1] “Alzheimer's Disease Fact Sheet.” *National Institute on Aging*.
<https://www.nia.nih.gov/health/alzheimers-disease-fact-sheet#:~:text=As%20Alzheimer's%20work%20C%20people%20experience.and%20personality%20and%20behavior%20changes>.
(accessed Sept. 19, 2023)
- [2] “Medication Management and Alzheimer’s.” *MemoryLane Care Services*.
<https://memorylanecareservices.org/medication-management-and-alzheimers/>
(accessed Sept. 19, 2023)
- [3] “What Are Decibels and How Can They Affect Hearing Health?.” *NCOA.org*
<https://www.ncoa.org/adviser/hearing-aids/decibel-levels/#:~:text=Sounds%20below%2070%20decibels%20are,decibels%20can%20damage%20your%20hearing>.
(accessed Sept. 19 2023).
- [4] Crowder, Crystal. “What Is a NIT of Screen Brightness and How Many Do You Need?” *Make Tech Easier*, 6 July 2021, www.maketecheasier.com/what-is-nit-of-screen-brightness/.
- [5] “Newton’s Second Law of Motion.” *The Physics Classroom*,
www.physicsclassroom.com/class/newtlaws/Lesson-3/Newton-s-Second-Law.
(accessed Sept. 19 2023).
- [6] Fluke. “What Is Ohm’s Law?” *Fluke*, 29 Mar. 2023,
www.fluke.com/en-ca/learn/blog/electrical/what-is-ohms-law.
(accessed Sept. 19 2023).
- [7] Centre, Scottish Sensory. “BSL Physics Glossary - Time Interval .” *Time Interval*,
<http://www.ssc.education.ed.ac.uk/BSL/physics/intervald.html#:~:text=A%20longer%20length> (accessed 20 Sept. 2023)

